

REMARKS

After the foregoing Amendment, claims 1 through 23 are currently pending in this application. Applicant submits that the claim amendments are fully supported by the disclosure and that no new matter has been added.

The Examiner has objected to claim 1 because of a typographical error in line 4. The error has been corrected in the preceding amendment and the applicants respectfully request the withdrawal of this objection.

The Examiner has rejected claims 1-23 under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point and distinctly claim the subject matter which applicants regard as their invention. In response, claims 1 and 18 are amended as the Examiner suggests, pluralizing "said grating zone" in the last step of each claim to read "said grating zones". Accordingly, the applicants respectfully request withdrawal of this rejection.

In order to more clearly distinguish the features of the present application, claim 1, as amended, recites "forming and hard baking under a relatively low temperature a photoresist on said silicon oxide layer for defining a plurality of specific zones". This amendment is supported by paragraph [0049] of the specification.

The Examiner has rejected claims 1-23 under 35 U.S.C § 103(a) as being unpatentable over Applicants' discussion of the prior art in the specification in view of either U.S. Patent No. 6,238,581 to Hawkins et al. (hereinafter Hawkins) or U.S. Patent Application No. 2004/0027225 to Lee et al. (hereinafter Lee). The Examiner has further rejected claims 1-23 under 35 U.S.C § 103(a) as being unpatentable over Applicants' discussion of the prior art in the specification in view of either U.S. Patent Application No. 2004/0224523 to Bae et al. (hereinafter Bae) or Japanese

Patent No. 6-343272 to Sato (hereinafter Sato). Applicants respectfully disagree and request withdrawal of this rejection for the reasons set forth below.

The Examiner asserts that Applicants' discussion of the prior art in the specification substantially teaches the invention as claimed, with the exception that the prior art utilizes aluminum or copper as the material of the sacrifice layer (i.e. corresponding to the layer formed in step (c) of Claim 1 and step (b) of Claim 18, and removed in step (j) of Claim 1 and step (g) of Claim 18). Based on paragraphs [0004] through [0009] of the specification, the Examiner indicates that Applicants' discussion of the prior art does not recognize utilizing silicon oxide as the material of the sacrifice layer is known. Nevertheless, the Applicant respectfully points out that additional technical features of the present application are neglected.

The present application provides a method for manufacturing a grating, in which a plurality of distinguishable steps is involved. More specifically, for defining a plurality of specific zones which contain concaves for forming structural pillars therein, a photoresist is formed on the silicon oxide, i.e. the sacrifice layer, and is hard baked at a relatively low temperature. Besides, an adhesive layer such as Cr and a conductive layer such as Au are formed on the grating zones of the grating.

In contrast, Hawkins discloses a process for manufacturing an electro-mechanical grating device in which the actuation conditions for the deformable elements are equal throughout the whole device. The process comprises the steps of depositing and then removing a sacrifice layer, wherein the material of the sacrifice layer is selected from a group including silicon oxide. The technical features thereof exist in that the common PSG (phosphosilicate glass) sacrifice layer is replaced by the silicon oxide sacrifice layer, and in that after depositing the sacrifice layer on the patterned space layer, a polishing process, preferably a CMP process, is performed to polish the surface of the sacrifice layer. Based on the specification

(col. 6, lines 58-66) of Hawkins, the polished surface of the sacrifice layer filling in the channel is polished to be optically coplanar with the top surface of the spacer layer so that a light beam reflected from the top surface of the next-to-be-deposited ribbon layer would always be reflected specularly even in the region in which the ribbon layer contacts the sacrifice layer and the top surface of the spacer layer. Therefore, the diffraction efficiency of the device is improved.

Lee discloses a micro electromechanical differential actuator comprising a suspension arm structure and/or a bridge structure to make a two-degree-of-freedom and bi-direction motion. Based on the specification, specifically paragraph [0031] and Figs. 11A to 11D, a surface micromachining micro electromechanical procedure is applied for manufacturing the suspension arm structure and/or the bridge structure. In this procedure, the first sacrifice layer 62 made of silicon oxide is deposited on the silicon substrate, and subsequently the first sacrifice layer pattern, the first structure layer 63, i.e. the suspension arm structure, of the differential actuator and a post connection part of the substrate are formed by RIE along with photo mask etching. Then, the second sacrifice layer 64 of the differential actuator is formed by RIE and photo mask etching. The above processes are repeated to form the second structure layer 65, i.e. the bridge structure, of the differential actuator, and finally the structure releasing is performed so as to obtain a desired differential actuator which performs a two-degree-of-freedom and bi-direction motion.

Bae discloses a method for fabricating an anti-stiction micromachined structure that can prevent the stiction between a microstructure and a substrate or adjacent structures after etching for releasing the microstructure. Based on the specification, specifically paragraphs [0016] and [0017], Figs. 2A to 2D, a dry-etchable material such as a polymer or polycrystalline silicon (polysilicon) is

deposited on the substrate so as to form an anti-stiction layer 101, and thereon a sacrifice layer 103 of PSG, silicon oxide, low temperature oxide, copper, iron, molybdenum, nickel, chrome, or TEOS is deposited. Then, the anti-stiction layer 101 and the sacrifice layer 103 stacked on the substrate 100 are etched with a mask 105 to form a hole 107 for a post, and after being released, the desired micromachined structure (microstructure) 109 is fabricated over the resulting structure from which the mask 105 has been removed.

Sato discloses an H₂O-TEOS plasma CVD method for uniformly depositing a conformal sacrifice layer of silicon oxide. According to the specification, specifically paragraphs [0005]-[0006], such a technique is provided in order to overcome the drawback resulting from the conventional CVD method.

In comparison with the cited references Hawkins, Bae, Lee, and Sato, it is apparent that there are at least two distinguishable technical features in the present application. The first distinguishable feature being the low temperature hard baking treatment of the photomask, i.e. step d) recited in independent claim 1. The second distinguishable feature being the application of an adhesion layer, i.e. step h) recited in independent claim 1 and step e) recited in independent claim 18. Neither of these features are disclosed in the cited references. The differences between the claims and the cited art are explained in more detail below.

Regarding the basis for the Examiner's rejections, it is believed that independent claims 1 and 18 are rejected in view of the material of the sacrifice layer. The Examiner alleges the use of silicon oxide as the sacrifice layer has been disclosed in the cited references Hawkins, Bae, Lee, and Sato, which allows for the formation and release of an electrically actuated grating device.

As a person skilled in the art knows, silicon oxide is a commonly used material in the electromechanical process for fabricating the various

microstructures. It is also familiar to the skilled person that the fabrication of a suspended structure always involves the formation of the sacrifice layer and the removal thereof for releasing the structure. This is exactly the reason why such a technique is illustrated in the cited references. Nevertheless, the objects and the technical problems to be overcome by the present application are completely different from those of the cited references, so that a different manufacturing procedure is developed and provided therein.

First, a hard baking process with a relatively low temperature for hardening the mask is adopted in the method of the present application instead of the conventional short-time hard bake at high-temperature, e.g. higher than 150°C or even several hundred °C. Since the structural pillars of the grating device are fabricated via being defined by a mask which may significantly influence the appearances and configurations of the fabricated structural pillars and the straightness of the torsion elements, the rigidity of the mask plays an important role and needs to be enhanced as much as possible. However, in the conventional procedures, the short-time hard bake with high-temperature always results in a deformation of the mask and the configuration of the structural pillar would be changed accordingly. For preventing the mask from being deformed, the hard baking process in the present application is proceeded under a relatively low temperature for a relatively long period of time, i.e. 70~90°C, for 2~5 hours, so that the shape of the baked mask is maintained while being hardened.

Second, an inventive step in the present application is to form an adhesive layer on the grating zones before the conductive layer is deposited thereon. According to the recitations in claims 1 and 18 and the illustration of the specification, the application of the adhesive layer allows the conductive layer and the adhesive layer to sustain the HF acid for about 20 minutes while the structure

is released, so as to prevent themselves from being spoiled and lift-up. In comparison with the conventional ones, such a procedure improves the adhesive property a lot and increases the sustaining period of the adhesive layer with the conductive layer from 7-8 minutes to 20 minutes.

In addition, another great effect achieved by the present invention is that the amount of masks applied therein is less than that applied in the conventional manufacturing method, and hence the process is more simplified. Typically, in the prior art, three masks are required for performing the conventional manufacturing method, which includes a first one for manufacturing a bottom electrode, a second one for determining the structural pillars and a third one for defining the main body of the grating device. As for the present invention, however, the photoresist layer which is hard baked under a relatively low temperature is rigid and strong enough for masking, so that the mentioned second mask for determining the structural pillars is able to be replaced, which further shows the novelty and progressiveness of the present application.

Therefore, the features of the present invention are not taught or fairly suggested by the cited references. Applicants therefore request reconsideration of the independent claims 1 and 18 as currently amended.

With respect to claims 2-17 and 19-23, as currently amended, which depend either directly or indirectly from independent claims 1 and 18, respectively, for the reasons presented above the applicants respectfully submit these claims are in condition for allowance.

Applicant: Huang et al.
Application No.: 10/812,133

CONCLUSION

In view of the foregoing Amendment and remarks, Applicant respectfully submits that the present application, including claims 1 through 23, is in condition for allowance and a notice to that effect is respectfully requested.

If the Examiner believes that a telephone interview will facilitate allowance of the claims, he is respectfully requested to contact the undersigned at 215-568-6400.

Respectfully submitted,

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